DETERMINATION OF REAL WORLD OCCUPANT POSTURES BY PHOTO STUDIES TO AID SMART RESTRAINT DEVELOPMENT.

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ABSTRACT

The "**P**roposed **R**eduction of car crash **I**njuries through improved **SM**art restraint development technologies" (PRISM) project is a European Commission funded 5th Framework project that is intending to determine appropriate smart restraint technologies for Europe.

This photographic study was undertaken as part of the PRISM project. The purpose of the study was to obtain statistical information regarding driver and passenger postures under normal driving conditions. The results gave a clear indication of real world postures at impact that should be considered for smart restraint systems.

Rural and urban sites were selected in Spain, Austria and the United Kingdom, representing southern, central and northern Europe. Sites were scrutinised for their suitability to film. Film analysis was undertaken on each vehicle filmed.

The primary measurements taken were: Driver nose to steering wheel, Driver head centreline to vehicle centreline and Passenger head centreline to vehicle centreline. Other parameters noted included use of seatbelts, hand positions, luggage locations etc. In all, 12 vehicle parameters and 15 driver parameters were noted per vehicle with additional parameters for each passenger, where appropriate. In total, over 4800 vehicles were filmed and analysed.

The site selection and survey methodology are described. Various issues, such as time-of-day and location influences, together with the limitations associated with the methodology are also presented.

Following a discussion of the results, a number of conclusions have been drawn, regarding statistical distributions of various parameters and their importance in occupant protection and for smart restraint design.

Although similar previous studies have been undertaken (MacKay, Hassan, Hill, 16th ESV, Windsor also Parkin, MacKay, Cooper, Proceedings, AAAM, Nov 93), this study utilises a wider range of sites, a larger sample size, and due to technology improvements better image quality, leading to an improved quality of data collection. Societal trends, such as the use of mobile phones, etc are also noted.

INTRODUCTION

It is widely accepted that vehicle occupants do not maintain exactly the same postures as crash ATDs (Anthropomorphic Test Devices) during normal driving, nor under the stressful conditions of vehicle pre-impact manoeuvres such as emergency braking. Consequently, their posture at the point of impact may be quite different from the ATD postures used for restraint system development and evaluation. "Out of Position" tests are undertaken as static or dynamic tests. However, the relevance and importance of specific tests are not widely agreed and are unlikely to be of the same priority in different parts of the world where many environmental conditions vary and legislation differs.

As the implementation of "smart" restraint systems increases it is important to specify the true priority posture cases that such systems must handle successfully. This paper discusses work package 1.4 "Investigate occupant position by photographic studies" undertaken within the project "PRISM" to determine the priority cases for the European market. The results of this work package are included in this report, although as the results will be used to feed in to other work packages such as *"Improved Understanding Of Passenger Behaviour During Pre-Impact Events To Aid Smart Restraint Development"* and *"The Effect Of Driver Positioning On The Dynamic Response To A Potential Accident Event"*, final conclusions cannot be drawn from this work, but are expected at the end of this project in 2005. This paper reports the simple results and conclusions from this work packages alone.

"Investigate Occupant Position by Photographic Studies", was undertaken to determine how occupants sit in vehicles on the roads of Europe. Over 5000 vehicle samples were taken from six test sites, two in the UK, two in Austria and two in Spain. These samples were analysed to determine occupant longitudinal, lateral and upper limb locations. The practical result of this task was to provide realistic real world postures that could be considered as "pre-event" start positions for the second phase mentioned above known as *"Improved Understanding Of Passenger Behaviour During Pre-Impact Events To Aid Smart Restraint Development"* which determined how occupants behave within the vehicle in the pre-impact phase, such as emergency braking, swerving etc. This paper covers the work, lead by MIRA Ltd. A range of pre-impact manoeuvre events were undertaken and the human occupants were encouraged to adopt various postures based on those found in this study before the events took place. A similar study within the project "*The Effect Of Driver Positioning On The Dynamic Response To A Potential Accident Event",* was undertaken by TRL Ltd., which studied the driver behaviour using a static driving simulator (Couper, 2004). This also used the "pre event" start positions.

A database was built in Microsoft Access© and was used to analyse all the vehicle samples. Whilst similar studies have been undertaken before (Parkin, 1993 and Mackay, 1998) this new study considers a larger sample, from a wider range of sites. Many aspects measured in this study are more detailed, especially the passenger measurements, other aspects are less detailed than previous studies in particular more generalised driver hand positions. It is also possible that the behavioural changes of the population may have changed since the previous studies so this study is likely to be more relevant to today's conditions.

METHODOLOGY

The photographic installations were selected based on a number of specific requirements. These include the ability to film from the front of the vehicle at high level and downwards (from a bridge, high building etc.) and the ability to hide the cameras to some degree (to limit reactions to the cameras). The highway and motorway installations used a long duration high-speed camera (H) at 125fps (frames per second) to ensure good framing of the driver window and to minimise blur. The frontal cameras were conventional video cameras (V) at 25 fps since rate of vehicle progression through the frame was much lower (Figure 1.). The single carriageway sites did not require such rapid frame rates for the side camera, so a conventional video camera was used (Figure 2.).

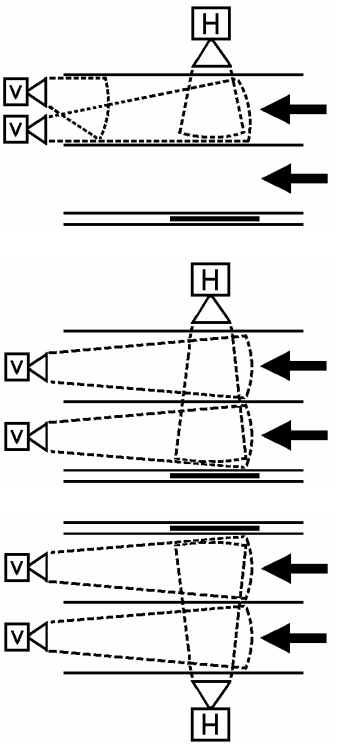

Figure 1. Highway and motorway camera configurations.

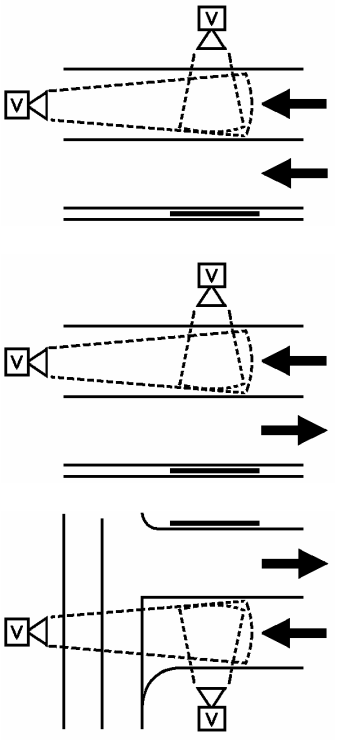

Figure 2. Urban and rural minor road camera configurations.

Rural high speed roads and urban low speed sites were selected in Spain, Austria and the United Kingdom. All sites bar one in the UK were chosen with bridges to position the cameras. Examples of high speed and low speed locations are given below. One of the high speed location in Spain was on a motorway heading out of Madrid (Figure 3.) the cameras are situated laterally and above on the bridge to give frontal images.

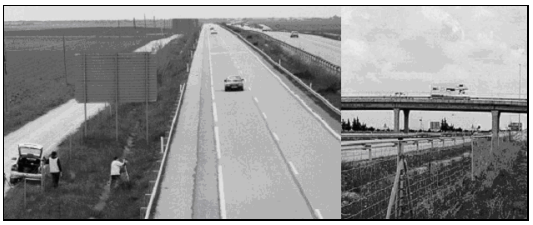

Figure 3. Site 1 Spanish Motorway

Austria's low speed site (Figure 4.) was in the city centre in Linz with the lateral camera hidden behind a sign and frontal cameras on the bridge.

Figure 4. Site 3 Austrian City

A chequered board was placed behind the sample vehicle in the centre reservation, or on the other side of the road, so that it could be seen in the background. (Figure 5.) The frontal camera images were firstly used to record the virtual lateral head positions of the front seat occupants and make observations. The occupant head positions were also measured virtually from the nose to the vehicle centre line (Figure 6.). The virtual measurements were quantified by a physical parameter study. The frontal camera(s) also provided lateral location information relative to tape marks on the road, which were a known distance from the side camera and the chequer board.

By trigonometry the depth / parallax error in the driver posture measurements could be reduced. These errors were monitored on a number of samples by taking the measurements of the side windows on the sample images and then by checking on a similar static vehicle by direct measurement. Of the samples that were checked, the typical accuracy was +/- 3% with the worst case being just over 5%.

Figure 5. Side camera measurements.

Figure 6. Frontal camera measurements.

One important requirement for each site was to have sufficient traffic samples when the sun was in the correct position to minimise glass reflections. By experimentation with angles and polarising filters, it was normally possible to obtain a run time of 2 hours with the sun in a suitable position and with sufficient traffic flow. (Figure 7.) It was necessary that the reflection criteria were met for both the frontal and side cameras simultaneously. There was an initial target of 2000 vehicle samples per site.

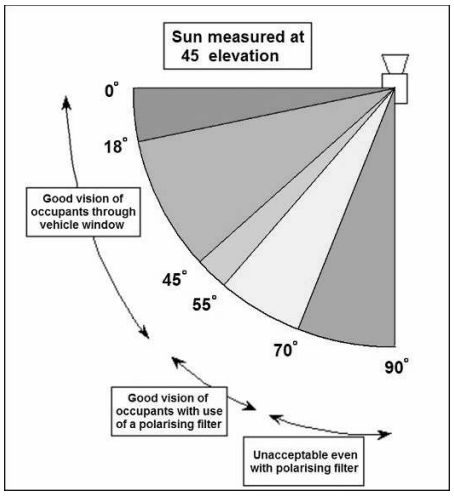

Figure 7. Acceptable sun angle.

The observed data werexc entered into a custom made database designed for ease of data entry and for clear parameter option selection. (Figure 8.) The database allowed all the information derived from the images to be input quickly and efficiently.

The database had a viewing pane where all the available image thumbnails could be selected to show full resolution versions for each vehicle. It enabled the vehicle data to be input such as model, manufacturer, hand of drive, and seating configuration. Driver details included such items as age, gender, build and hand and arm positions. The database was also able to calculate in millimetres the distance from the nose of the driver to the steering wheel, the driver head centre line and the passenger head centre line to the centre of the vehicle by entering in the pixel positions. Passenger information was extensive, front passenger age, gender build etc was entered along with hand and arm positions and similarly for each further occupant. Options for child seat and child position were also available.

Extra details such as type of vehicle ie was it a sports car or MPV, whether the windows or sunroof were open, whether occupants wore glasses or not etc were also input at this stage.

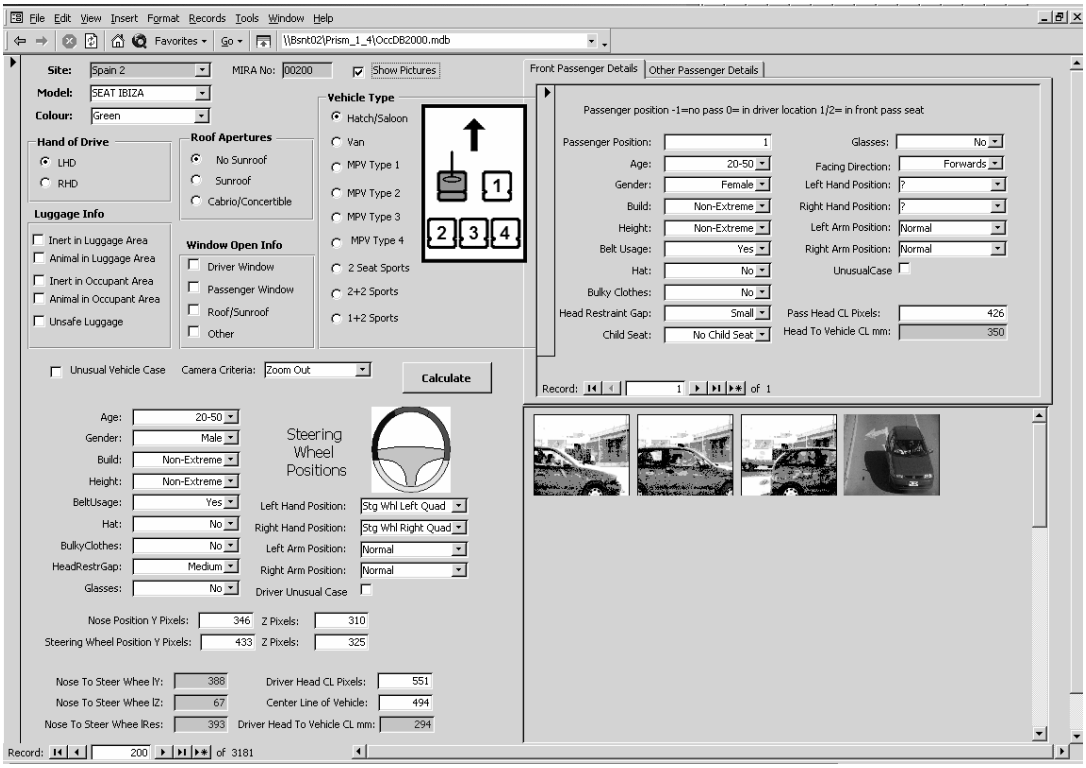

Figure 8. Database main input screen.

DATA AND RESULTS

The study covered vehicles in 3 countries. The 5106 vehicle samples were obtained from: Austria (approximately 40%), Spain (approximately 18%) and UK (approximately 42%). Although Spain had a low vehicle count it had one of the highest numbers of rear passengers in the study. Whilst the sites were selected to give approximately the same volumes of vehicles and each site had a 2 hour filming period, the final distribution was unbalanced. Poor weather and light meant that the Spanish motorway study had a shorter time span.

The results are split into several sections in order to give an example of the data obtained. It should be stated that with the use of the database any of the information available can be compared and contrasted with each other. The following results are identified as most relevant to the later stages of the PRISM Project. Results are also listed in Appendix 1.

Seatbelt Usage

Overall driver seat belt wearing was 93% with 5% clearly not wearing belts and 2% unclear. Female drivers and passengers had a higher seat belt usage rate than males. Spanish drivers were least likely to wear seat belts around town (26% non-use) but the sample sizes of Spanish motorway and UK village were too small to give reliable belt wearing rate indication.

Passenger overall seat belt wearing was 90% with 7% clearly not wearing belts and 3% unclear. It would appear that from the study that drivers were more likely to wear belts than passengers, except in Spain around town, where unbelted male drivers with belted female passengers were very noticeable.

Vehicle Occupants

Overall, 78% of the vehicles were driver only and 20% had only one passenger. The day of week, time of day and local geographical location are all considered to have had an influence on the numbers of passengers observed. These varied considerably. Significant trends between rush hour, workday and weekends were observed. Children were most frequently observed on weekend days, despite the UK village site and time being selected to capture children going to school.

Age

The age of each occupant was estimated from appearance with the intention of identifying numbers of young and old occupants. Overall, 8% of drivers were judged to be over 50 years of age, 91% of drivers were between 20-50 years of age and the final 1% being judged under 20 years of age. Of the front seat passengers, 12% were estimated to be over 50 years, 10% adults under 20 years, and approximately 8% were estimated to be children. Based on these estimations it is suggested that only 32% of rear passengers were between 20-50 years of age and approximately 45% were children.

Gender

Overall quantities for drivers were 76% male, 24% female, for front passengers were 31% male 69% female. Rear occupants were very difficult to determine as side camera shots often only showed occupants from the neck upwards.

Head Position

The resultant distance from driver's nose to steering wheel top varied from a mean of 430 mm for females to a mean of 470mm for males (Figure 9.). A total of 17 drivers (10 male, 7 female) were measured as less than 200mm. The most extreme cases were one female at under 50mm and another between 50 and 100mm.

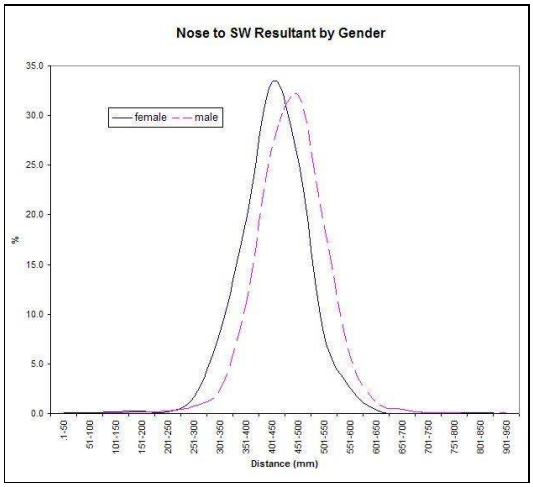

Figure 9. Nose to Steering Wheel by Gender

The gap between the driver head and the head restraint proved difficult to estimate because it was screened by the B-post for many vehicles. Bulky hair was also a problem in some cases. Where it was reasonable to estimate the gap three choices were possible: large gap (occupant visibly leaning forward) of which there were 11%, medium gap (relatively normal in appearance) of which there were 78% and small gap (touching or up to approx 50mm), of which there were 9%.

Hand & Arm Positions

The driver's hand position has been examined in 2 ways the first looking at results for each hand separately confirms expectations that most drivers hold the steering wheel in the upper left and right hand quadrants of the steering wheel (48%). After this the next most popular position is the bottom quadrant, (17%) the top quadrant, (12%) then the gearshift (10%). The driver's arms tended to follow the obvious natural route to the hand position (94%) but sometimes rested on the armrest (3%) or out of the window (0.5%).

Secondly, the left and right hand positions are compared to each other, i.e. both hand positions are examined together. (Table 1.) It can be seen that the most popular position is placing the hands at the "ten-to-two" or "quarter–to-three" positions (33%).

The most common position for the passengers was to have their hands on their laps. (45% had both hands in their lap). It was often difficult to see the passenger's hands as this depended greatly on the height of the camera. This meant that a high proportion of the passengers' hands could not be seen (27% where one or both hands could not be seen). The most common position for a passengers arm was in its natural position derived from the position of the hand. The next most common position for the passenger arms was crossed. Approximately 6% were involved in some activity using one or more hands (reading, drinking, on telephone, etc.) and 2 to 3% were holding a grab handle.

Unusual Cases

As data was input into the database it was possible to select it as an unusual case. A number of samples were recorded as unusual cases where some aspect of posture or other safety issue was noted that had not been considered before analysis. These are summarised here:

- Driver unusual cases: From 19 unusual cases the most common for drivers was smoking (total 7) followed by no hands on the steering wheel (5) and having arms across the body (2). Other unusual cases were driver leaning into the footwell show in Figure 10.

- Front passenger unusual cases: From 31 unusual cases, animals in the passenger area are most common for front passengers (total 5, mostly dogs on passengers laps). Next was holding or adjusting the seat belt (4). Luggage on the facia, sleeping and bending into the footwell were also highlighted (3 each). Including child standing in the footwell area (Figure 11.).

- Rear passenger unusual cases: From 33 unusual cases, a child standing on the seat or on the floor was most common for rear passengers (total 10). Next is the occupant leaning forward, often between the front seats (7)

Figure 10. Example of driver leaning into footwell

Table 1. Driver hand position related to left and right hand.

Right hand across / Left Hand down	?	Centre of Wheel	Distant Control	Drink / Food	Gear Shift	Gesture at Camera	Grab Handle	Map / Book / Papers	Nose / Mouth	Other	Out of Window	Phone / Head Side	Stg Whl Bot Quad	Stg Whl Left Quad	Stg Whl Right Quad	Stg Whl Top Quad	Grand Total
?	1.30%	0.08%			0.08%	0.04%				0.02%		0.02%	0.44%	0.02%	2.28%	1.38%	5.68%
Centre of Wheel	0.08%	0.13%			0.08%					0.02%		0.02%	0.04%	0.00%	0.10%	0.02%	0.50%
Distant Control												0.02%	0.08%	0.00%	0.29%	0.04%	0.44%
Drink / Food				0.02%									0.02%	0.00%	0.04%		0.08%
Gear Shift	0.02%	0.06%								0.02%			0.36%	0.04%	3.25%	1.17%	4.93%
Gesture at Camera													0.02%		0.10%	0.02%	0.15%
Grab Handle															0.10%	0.02%	0.13%
Left Quad		0.02%															0.02%
Map / Book / Papers								0.02%							0.02%		0.04%
Nose / Mouth	0.08%				0.02%				0.02%	0.02%			0.27%		1.05%	0.40%	1.87%
Other	0.02%									0.00%			0.19%	0.02%	1.36%	0.63%	2.22%
Out of Window					0.02%					0.00%			0.04%		0.13%	0.10%	0.29%
Phone / Head Side					0.06%					0.02%		0.04%	0.52%		0.75%	0.19%	1.59%
Stg Whl Bot Quad	0.06%		0.02%	0.06%	2.39%	0.06%			0.21%	0.38%	0.04%	0.25%	11.76%	0.13%	1.87%	1.11%	18.34%
Stg Whl Left Quad	1.26%	0.06%	0.10%	0.08%	6.71%	0.15%	0.02%	0.04%	0.96%	0.78%	0.02%	0.80%	1.68%		32.93%	2.72%	48.31%
Stg Whl Right Quad	0.10%		0.04%	0.02%	0.65%			0.02%	0.06%	0.06%		0.06%	0.02%		0.19%	0.02%	1.26%
Stg Whl Top Quad	0.80%		0.10%	0.04%	5.97%	0.02%	0.06%	0.04%	0.31%	0.48%		0.31%	0.67%		2.62%	2.70%	14.15%
Grand Total	3.73%	0.36%	0.27%	0.23%	15.99%	0.27%	0.08%	0.13%	1.57%	1.80%	0.06%	1.53%	16.12%	0.21%	47.10%	10.54%	100.0%

Figure 11. Example of front seat passenger – child standing in footwell

Manufacturer

Vehicle manufacturer simply shows the most common vehicle in that region. The UK shows Ford and Peugeot as being most popular. Spain shows Renault and Seat and Austria shows Volkswagen and Opel.

Miscellaneous

Other aspects that may be of interest were noted when it was reasonably easy to do so. Some of these were:

- Glasses: Over 29% of drivers and over 28% of passengers wore glasses. Spain showed the highest use with 48% of drivers wearing glasses (Figure 12.). This could be attributed to the bright sunshine meaning a high use of sunglasses rather than clear prescription lenses (not a distinction drawn in this study). Spain also had the highest number of front passengers wearing glasses.

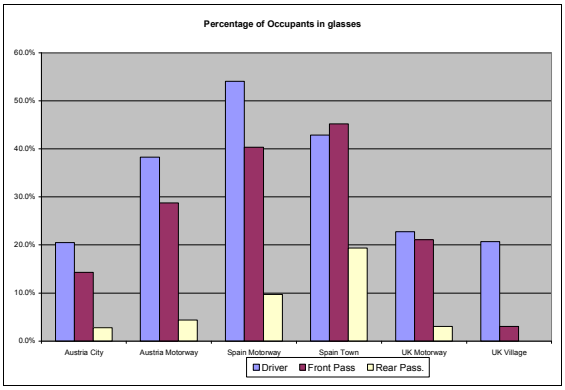

Figure 12 Percentages of Occupants in Glasses

- Luggage: Generally, visible luggage consisted of home improvement materials, such as wood planks etc. or travel luggage, such as suitcases, in estate vehicles.

- Child seat use: Most children appeared not to be seated in a child seat, although this was very difficult to see in the rear of the car as it was below the side camera view. It appeared that the use of child seats was only 5% in the front seat and 14% in the rear seat, However, this is likely to be an underestimate as some child seats, especially "booster" cushion types and dark coloured child seats may have been present but not discernable.

- Facing direction: In most cases (95%) front passengers are facing forward. Side facing occupant data could be anomalous as at most sites the chequer board was visible and may have attracted their attention.

CONCLUSIONS

The collected data was highly dependent on certain factors, such as weather, time of day, proximity to public amenities etc. Whilst some efforts were made to minimise these factors, the practicalities of obtaining the data (such as having good daylight for filming, etc.) meant that these effects could not be eliminated. Therefore these conclusions are MIRA Ltd's interpretation of the results. The results are a statistical statement of the facts. Although statistics can be altered, we have tried to be factual and simplistic in all statements. It must be taken into consideration that the conclusions are the opinion of the author.

The following statements summarise the results gathered;

It seemed more popular to wear a seat belt on longer journeys on the fast moving roads. A higher percentage of seatbelt wearers are female. It also seems that Spain had the highest proportion of non seat belt wearers.

The number of vehicle occupants varied from site to site dependant on the time of day or the day of the week. These variables have to be considered at all times. Improvements could be made to this process such as if the system of collation could be automated to film the vehicles at any time of day and to analyse each vehicle to show occupant position automatically then this would prove to be an invaluable resource. Results could be taken at different times of day and on different days of the week showing demographics of all the regions. The only limiting effect of this would be the lighting, as bright sun light and darkness would mean poor results.

The age groups were chosen to show extremes of ages. Most drivers were estimated to be in the 20–50 years of age category, which was expected. It was possible to see that males dominated this group for drivers and females dominated the group for passengers. The results showed that 20-50 years of age was the most common age group site wide. Rear passengers were estimated to be considerably younger with only 30% being in the 20-50 year old group and over 40% either large or small children or baby's under 1 year old.

Driver gender showed that most drivers were male and most passengers were female site wide.

Although it was difficult to see the head restraint gap the majority of drivers and passengers sat with a medium head restraint gap - HRG. This could be explained by the fact that large HRG was recorded when the gap looked to be extreme, and a small HRG was recorded when no gap could be seen. The results show that by a marginal difference more female drivers had a larger HRG than males, although female drivers also exceeded male drivers with a small HRG.
Female passengers had a higher amount of small HRG than male passengers. Male passengers had a higher amount of large HRG.

Nose to steering wheel resultant shows us that drivers have an average nose to steering wheel measurement of 475mm, comparing the results for male and female it can be seen that females sit approximately 50mm closer to the steering wheel than the males.

The hand and arm position of the drivers was examined to show that the most common position for a driver is to hold the steering wheel in the top left and right quadrants. The quadrant of the steering wheel that the driver holds does vary and is related to the use of the gearshift. The filming location may also have affected the gearshift result, such as approaching a junction compared to a high speed road.

This study showed that around a third of drivers and passengers wear glasses. This must show that the effect of wearing glasses must be considered in future testing. It also highlighted luggage dispersal, child seat use and occupant facing direction. Details are listed in appendix 1. All of this information can be used in further projects.

The unusual cases highlighted in this study were only a small proportion of the total vehicles analysed but it highlighted the possible extreme scenarios of how occupants position themselves within vehicles. Whilst the observations above may be of interest for those developing restraint systems, the primary purpose was to identify the postures that the volunteers should adopt in the occupant behaviour tests. After discussions with various members of the project consortium it was decided that various postures would be used based on incidence and potential severity.

These positions have been used to help determine scenario positions for Task 1.5 'Occupant Behaviour During Pre-Impact Braking'. These are summarised in Table 2.

Table 2. Passenger postures identified for further dynamic study.

Stable Postures
Normal position, hands on lap
Arm on door armrest
Arm on waist rail
Arm out of window
Arms crossed
Holding roof grab handle
Legs crossed at ankle
Feet forward (braced)
Feet rearward (unbraced)
Activity Postures
Looking in vanity mirror
Adjusting seat belt
Adjusting radio / vehicle controls
Using mobile phone
Reading
Higher Risk Postures
Sitting on foot / feet
Facing rear direction
Drinking / eating
Reaching into foot well
Unbelted

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APPENDIX 1

Total Vehicles Involved in Study by Site.

- Austria City 17.20% (821 vehicles)
- Austria Motorway 23.04% (1100 vehicles)
- Spain Motorway 3.06% (146 vehicles)
- Spain Town 14.66% (700 vehicles)
- UK Motorway 38.29% (1828 vehicles)
- UK Village 3.75% (179 vehicles)

Seatbelt Usage

Drivers Belt Usage:

Results from a total number of 4774 drivers

- 5% of Drivers at all sites do not wear seat belts

Site based results for not wearing a seat belt:

- Spain Motorway less than 1%
- UK Motorway 1%
- UK Village 1%
- Austria Motorway 1%
- In Austria City 4%
- Spain Town 26%

Driver Belt Usage by Gender:

- 6% of all Male Drivers
- 2% of all female drivers did not wear seat belts.

Country based results for occupants not wearing seatbelts:

- Spain
  - 22% male
  - 17% female
- UK
  - 2% males
  - 0.2% females.
- Austria
  - 3% of males
  - 1% of females

Front Passenger Belt Usage:

Results from a total of 2130 front passenger occupants.

7% of Passengers from all sites do not wear seat belts

Site based results for not wearing a seat belt:

- Spain Motorway 0.96%
- Spain Town 19.43%
- UK Motorway 2.2%
- UK Village 16.13%
- Austria City 4.76%
- Austria Motorway 4.76%

Front Passenger Spread by site:

- Spain Motorway 4.9%
- Spain Town 21.5%
- UK Motorway 40.5%
- UK Village 1.5%
- Austria City 7.9%
- Austria Motorway 23.8%

Front Passenger Belt Usage by Gender:

- 9% of all Male Passengers did not wear seat belts.
- 6% of all female passengers did not wear seat belts.

Country based results for front passengers not wearing seatbelts;

- Spain
  - 18% male
  - 15% female
- UK
  - 5% males
  - 2% females
- Austria
  - 8% males
  - 2% females

Vehicle Occupants

Number of Passengers in Vehicle; (The results have been split down to show the percentage of vehicles that have 1, 2 and 3 passengers in them)

Austria City

- Driver only 77.5%
- 1 passenger 20.5%
- 2 passengers 1.7%
- 3 passengers 0.4%

Austria Motorway

- Driver only 51.0%
- 1 passenger 41.0%
- 2 passengers 7.2%
- 3 passengers 0.8%

Spain Motorway

- Driver only 19.9%
- 1 passenger 51.4%
- 2 passengers 21.2%
- 3 passengers 6.8%
- 4 passengers 0.7%

Spain Town

- Driver only 28.7%
- 1 passenger 46.7%
- 2 passengers 15.0%
- 3 passengers 8.7%
- 4 passengers 0.7%
- 5 passengers 0.1%

UK Motorway

- Driver only 48.9%
- 1 passenger 38.8%
- 2 passengers 8.6%
- 3 passengers 3.1%
- 4 passengers 0.5%
- 5 passengers 0.1%

UK Village

- Driver only 82.1%
- 1 Passenger 15.1%
- 2 Passenger 2.8%
-

Age

Driver Age

- 8% of drivers were over 50 years of age
- 91% of all drivers were between 20-50 years of age
- 1.2% of drivers were under the age of 20

Site Based Results;

- Spain Town
  - 1.1% under 20 years of age
  - 91% 20-50 years of age
  - 8% over 50 years of age
- Spain Motorway
  - 90% 20-50 years of age
  - 10.3% over 50 years of age
- UK Motorway
  - 1.9 % under 20 years of age
  - 91% 20-50 years of age
  - 7.1% over 50 years of age
- UK Village
  - 0% under 20 years of age
  - 95% 20-50 years of age
  - 4.5% over 50 years of age
  - 0.6% indeterminable
- Austria City
  - 0.9% under 20 years of age
  - 89% 20-50 years of age
  - 10.1% over 50 years of age
- Austria Motorway
  - 0.9% under 20 years of age
  - 92% 20-50 years of age
  - 6.7% over 50 years of age

Driver age by Gender.

- Under 20 years of age
  - 53% female
  - 47% male
- 20-50 years of age
  - 24% female
  - 76% male
- Over 50 years of age
  - 15% female
  - 85% male

Front Passenger Age

- 12.1% of front passengers were over 50 years of age
- 70.4% of front passengers were between 20-50 years of age
- 9.7% of front passengers were under the age of 20
- 4.2% of front passengers were large child
- 2.7% of front passengers were small child
- 0.3% of front passengers were baby to 1 year
- 0.7% were indeterminable

Site Based Results: (if not listed count is zero)

- Spain Town
  - 12% over 50 years of age
  - 75% 20-50 years of age
  - 9% under 20 years of age
  - 2% large child
  - 0.2% small child
  - 0.4% baby to 1 year
  - 1.5% indeterminable
- Spain Motorway
  - 12.8% over 50 years of age
  - 83.5% 20-50 years of age
  - 1.8% under 20 years of age
  - 1% baby to 1 year
- UK Motorway
  - 14% over 50 years of age
  - 62% 20-50 years of age
  - 12% under 20 years of age
  - 7% large child
  - 4.5% small child
  - 0.3% baby to 1 year
  - 0.6% indeterminable
- UK Village
  - 9% over 50 years of age
  - 45% 20-50 years of age
  - 27% under 20 years of age
  - 15% small child
- Austria City
  - 21% over 50 years of age
  - 69% 20-50 years of age
  - 8% under 20 years of age
  - 1.2% large child
  - 1.2% small child
- Austria Motorway
  - 7% over 50 years of age
  - 78% 20-50 years of age
  - 8% under 20 years of age
  - 4% large child
  - 2% small child

Front Passenger Age by Gender.

- Over 50 years of age
  - 76% female
  - 23% male
- 20-50 years of age
  - 71% female
  - 27% male
- Under 20 years of age
  - 51% female
  - 47% male
- Large child
  - 53% female
  - 37% male
- Small child
  - 24% female
  - 60% male
- Baby to 1 year
  - 17% female
  - 17% male
  - 66% indeterminable

Rear Passenger Age

- 4.3% of rear passengers were over 50 years of age
- 31.7% of rear passengers were between 20-50 years of age
- 15.6% of rear passengers were under the age of 20
- 13.9% of rear passengers were large child
- 25.9% of rear passengers were small child
- 3.5% of rear passengers were baby to 1 year
- 5.1% were indeterminable

Rear passenger age by Site: (if not listed count is zero)

- Spain Town
  - 4% over 50 years of age
  - 37.2% 20-50 years of age
  - 17.2% under 20 years of age
  - 11.7% large child
  - 19% small child
  - 1.8% baby to 1 year
  - 9.1% indeterminable
- Spain Motorway
  - 1.6% over 50 years of age
  - 46.8% 20-50 years of age
  - 8.1% under 20 years of age
  - 19.4% large child
  - 8.1% small child
  - 3.2% baby to 1 year
  - 12.9% indeterminable
- UK Motorway
  - 5.3% over 50 years of age
  - 23.5% 20-50 years of age
  - 13% under 20 years of age
  - 14.4% large child
  - 36.8% small child
  - 4.7% baby to 1 year
  - 2.2% indeterminable
- UK Village
  - 25% 20-50 years of age
  - 50% under 20 years of age
  - 25% small child
- Austria City
  - 2.8% over 50 years of age
  - 41.7% 20-50 years of age
  - 30.6% under 20 years of age
  - 8.3% large child
  - 11.1% small child
  - 5.6% baby to 1 year
- Austria Motorway
  - 4.4% over 50 years of age
  - 33.3% 20-50 years of age
  - 18.4% under 20 years of age
  - 16.7% large child
  - 21.9% small child
  - 3.5% baby to 1 year
  - 1.8% indeterminable

Rear Passenger Age by Gender:

- Over 50 years of age
  - 56.8% female
  - 35.1% male
  - 8.1% indeterminable
- 20-50 years of age
  - 48.9% female
  - 39.6% male
  - 11.5% indeterminable
- Under 20 years of age
  - 36.8% female
  - 54.9% male
  - 8.3% indeterminable
- Large child
  - 34.7% female
  - 48.3% male
  - 16.9% indeterminable
- Small child
  - 22.3% female
  - 35% male
  - 42.7% indeterminable
- Baby to 1 year
  - 6.7% female
  - 20% male
  - 73.3% indeterminable

Manufacturer

Vehicle Manufacturer Shown by Site

- Spain Town
  - Renault
  - Seat
- UK MW
  - Ford
  - Peugeot
  - Vauxhall
- Austria City
  - Volkswagen
  - Opel
  - Ford
- Spain Motorway
  - Seat
  - Renault
- UK Village
  - Ford
  - Peugeot
  - Vauxhall
- Austria MW
  - Volkswagen
  - Opel
  - Ford

Gender

Driver Gender

- 76.1% of all sites were male drivers
- 23.9% of all sites were female drivers

Driver Gender by site

- Spain Town
  - 87.6% male
  - 12.4% female
- Spain Motorway
  - 92.5% male
  - 7.5% female
- UK MW
  - 78% male
  - 22% female
- UK Village
  - 68% male
  - 32% female
- Austria City
  - 69% male
  - 31% female
- Austria MW
  - 70% male
  - 30% female

Passenger Gender

- 56% were male drivers
- 24% were female drivers

Passenger gender by site

- Spain Town
  - 25.7% male
  - 71.5% female
  - 2.8% were indeterminable
- Spain Motorway
  - 30.3% male
  - 65.1% female
  - 4.6% were indeterminable
- UK MW
  - 32.8% male
  - 65% female
  - 2.3% were indeterminable
- UK Village
  - 57.6% male
  - 36.4% female
  - 6.1% were indeterminable
- Austria City
  - 38.5% male
  - 60.9% female
  - 0.6% were indeterminable
- Austria MW
  - 27.4% male
  - 69.7% female
  - 2.9% were indeterminable

Head Position

Driver Head Restraint Gap

- 8.9% of all drivers had a small head restraint gap
- 78.1% of all drivers had a medium head restraint gap
- 11.8% of all drivers had a large head restraint gap
- 0.4% of all had no head restraint
- 0.8% of all were indeterminable

Driver head restraint gap by gender

Female

- 10.7% of females small sized gap
- 73.86% of females medium sized gap
- 14.74% of females large sized gap
- 0.44% of females no head restraint
- 0.26% of females were indeterminable

Male

- 8.34% of males had small sized gap
- 79.47% of males had medium sized gap
- 10.90% of males had large sized gap
- 0.33% of males had no head restraint
- 0.96% of males were indeterminable

Passenger Head Restraint Gap

- 11.1% of all drivers had a small head restraint gap
- 82.3% of all drivers had a medium head restraint gap
- 5.2% of all drivers had a large head restraint gap
- 0.3% of all had no head restraint
- 1.0% of all were indeterminable

Passenger Head restraint gap by gender

Female

- 11.4% of females had small sized gap
- 84.1% of females medium sized gap
- 3.5% of females had large sized gap
- 0.3% of females had no head restraint
- 0.7% of females were indeterminable

Male

- 11% of males had small sized gap
- 79.3% of males had medium sized gap
- 8.7% of males had large sized gap
- 0.3% of males had no head restraint
- 0.7% of males were indeterminable

Indeterminable

- 3.6% of small head gap gender was indeterminable
- 73.2% of Medium head gap gender was indeterminable
- 8.9% of large head gap gender was indeterminable
- 1.8% indeterminable gender had no head restraint
- 12.5% gender or gap size was indeterminable

Driver Head to centre line distribution - Medium vehicles

- The normal distribution (x) was 400 to 450 mm
- Males highest distribution sat between 300-350 mm
- Females highest distribution sat between 300- 350 mm

Nose to Steering Wheel Resultant

- The highest distribution shows that drivers sit between 451mm to 500mm

Nose to Steering Wheel Result by gender

- Females sit between 401mm and 450mm.
- Males sit between 451mm and 500mm.

Nose to Steering Wheel Resultant by Site

- Site results show drivers on all sites sit between 401-500mm.
- Spain Town generally sit closer to the steering wheel than Austria City.

Hand and Arm Positions

Driver Hand Positions

- ? (Unknown)
  - Left Hand 5.70%
  - Right Hand 3.73%
- Centre of Wheel
  - Left Hand 0.50%
  - Right Hand 0.36%
- Distant Control
  - Left Hand 0.44%
  - Right Hand 0.27%
- Nose / Mouth
  - Left Hand 1.86%
  - Right Hand 1.57%
- Drink / Food
  - Left Hand 0.08%
  - Right Hand 0.23%
- Gear Shift
  - Left Hand 4.92%
  - Right Hand 15.98%
- Gesture at Camera
  - Left Hand 0.15%
  - Right Hand 0.27%
- Grab Handle
  - Left Hand 0.13%
  - Right Hand 0.08%
- Map / Book / Papers
  - Left Hand 0.04%
  - Right Hand 0.13%
- Other
  - Left Hand 2.24%
  - Right Hand 1.84%

Driver Arm positions

- ? (Unknown)
  - Left Arm 0.7%
  - Right Arm 0.9%
- Across Body
  - Left Arm 0.7%
  - Right Arm 0.3%
- Arm Rest
  - Left Arm 4.1%
  - Right Arm 2.4%
- Crossed
  - Left Arm 0.1%
  - Right Arm 0.1%
- Normal
  - Left Arm 92.8%
  - Right Arm 95.3%
- Other
  - Left Arm 0.3%
  - Right Arm 0.6%
- Out of Window
  - Left Arm 1.1%
  - Right Arm 0.2%
- Out of Window
  - Left Hand 0.29%
  - Right Hand 0.06%
- Phone / Head Side
  - Left Hand 1.59%
  - Right Hand 1.53%
- Steering Wheel Bottom Quad
  - Left Hand 18.33%
  - Right Hand 16.11%
- Steering Wheel Left Quad
  - Left Hand 48.32%
  - Right Hand 0.21%
- Steering Wheel Right Quad
  - Left Hand 1.26%
  - Right Hand 47.09%
- Steering Wheel Top Quad
  - Left Hand 14.14%
  - Right Hand 10.54%
- Waist Rail
  - Left Arm 0.2%
  - Right Arm 0.2%

Passenger Hand Positions

- ? (Couldn't tell)
  - Left Arm 26.8%
  - Right Arm 25.4%
- Drink / Food
  - Left Arm 0.4%
  - Right Arm 0.4%
- Gesture at Camera
  - Left Arm 0.3%
  - Right Arm 0.6%
- Grab Handle
  - Left Arm 1.9%
  - Right Arm 2.8%
- Lap
  - Left Arm 46.4%
  - Right Arm 45.9%
- Map / Book / Papers
  - Left Arm 1.1%
  - Right Arm 1.4%
- Normal
  - Left Arm 16.2%
  - Right Arm 15.8%
- Nose / Mouth
  - Left Arm 2.1%
  - Right Arm 2.2%
- Out of Window
  - Left Arm 0.1%
  - Right Arm 0.8%
- Phone / Head Side
  - Left Arm 1.2%
  - Right Arm 1.1%
- Other
  - Left Arm 3.3%
  - Right Arm 3.6%

Passenger Arm Positions

- ? (Unknown)
  - Left Arm 2.1%
  - Right Arm 2.0%
- Across Body
  - Left Arm 1.2%
  - Right Arm 1.5%
- Arm Rest
  - Left Arm 1.9%
  - Right Arm 2.5%
- Crossed
  - Left Arm 4.2%
  - Right Arm 4.1%
- Normal
  - Left Arm 88.9%
  - Right Arm 87.9%
- Other
  - Left Arm 1.1%
  - Right Arm 1.0%
- Out of Window
  - Left Arm 0.3%
  - Right Arm 0.7%
- Waist Rail
  - Left Arm 0.4%

Hand Positions in relation to each other

- 32.9% left hand on steering wheel left quadrant right hand on steering wheel right quadrant
- 11.7% have both hands on the bottom quadrant of the steering wheel
- 6.71% left hand on steering wheel left quadrant right hand on gear shift
- 5.97% left hand on steering wheel top quadrant right hand on gear shift
- 3.25% left hand on gear shift right hand on steering wheel right quadrant
- 2.72% left hand on steering wheel left quadrant right hand on steering wheel top quadrant
- 2.70% left hand on steering wheel top quadrant right hand on steering wheel top quadrant
- 2.62% left hand on steering wheel top quadrant right hand on steering wheel right quadrant
- 2.28% left hand can not tell right hand on steering wheel right quadrant

Miscellaneous

Glasses;

- 29.8% of all Drivers wear glasses
- 28.3% of all Front passengers wear glasses

Driver wearing glasses by site;

- Austria City
  - Male 11.3%
  - Female 9.1%
- Austria Motorway
  - Male 23.5%
  - Female 14.7%
- Spain Motorway
  - Male 50.7%
  - Female 3.4%
- Spain Town
  - Male 37.3%
  - Female 5.6%
- UK Motorway
  - Male 16.9%
  - Female 5.9%
- UK Village
  - Male 10.6%
  - Female 10.1%

Front passenger wearing glasses by site;

- Austria City
  - Male 2.4%
  - Female 11.9%
- Austria Motorway
  - Male 5.2%
  - Female 23.2%
- Spain Motorway
  - Male 12.8%
  - Female 26.6%
- Spain Town
  - Male 11.9%
  - Female 33.3%
- UK Motorway
  - Male 6.1%
  - Female 14.9%
- UK Village
  - No glasses wearers

Luggage

- 7.5% of vehicles in Spain Motorway had luggage in the occupant area.
- 7.5% of vehicles in Spain Motorway had luggage in the luggage area.
- 5.9% of vehicles in UK Motorway had luggage in the occupant area.
- 3.1% of vehicles in UK Motorway had luggage in the luggage area.
- 3% of vehicles in Spain Town had luggage in the occupant area.
- 2.7% of vehicles in Austria City had luggage in the occupant area.
- 2.7% of vehicles in Austria City had unsafe luggage.
- 2.5% of vehicles in Austria Motorway had luggage in the occupant area.
- 2.1% of vehicles in Austria City had unsafe luggage.

Child seat use

- 86.1% had No Child Seat
- 12.2% had a forward facing seat
- 1.0% had a rear facing seat
- 0.8% had a child standing on the seat

Facing direction

- 95.9% of front passengers faced forwards
- 3.4% of front passengers faced sideways
- 0.5% of front passengers faced rearwards
- 0.2% of front passengers were on a lap facing forward
- 94.12% of rear passengers faced forwards
- 4.82% of rear passengers faced sideways
- 1.06% of rear passengers faced rearwards

Unusual Cases

Driver Unusual Case

- 36.8% smoking
- 21.1% no hands on wheel
- 10.5% arm across body
- 5.3% adjusting seatbelt
- 5.3% dog on lap
- 5.3% doing hair
- 5.3% large gap from steering wheel
- 5.3% head against steering wheel
- 5.3% radio adjustment

Front Passenger Unusual Cases

- 16.7% animal in passenger area
- 13.3% hand holding seat belt
- 10.0% luggage on facia
- 10.0% asleep
- 10.0% bent over looking in foot well
- 6.7% child on lap
- 6.7% arm under seatbelt
- 6.7% child stood in foot well
- 3.3% facing rearwards
- 3.3% feet on fascia
- 3.3% hand out of window
- 3.3% luggage on lap
- 3.3% no child seat
- 3.3% person holding baby

Rear Passenger Unusual Case

- 30.3% child stood up
- 21.2% leaning forward
- 9.1% unbelted not in place
- 9.1% child on lap
- 6.1% asleep
- 6.1% dog in rear
- 6.1% facing rearwards
- 3.0% hand out of window
- 3.0% dangerous luggage
- 3.0% looking rearwards
- 3.0% over crowded car